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Impact of health literacy on healthcare outcomes in hospitalized patients in Lebanon including quality of life and antibiotic knowledge

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This study aimed to assess health literacy (HL) levels among inpatients and evaluate its association with health-related quality of life (HRQoL), antibiotic use and knowledge, health services need, adverse drug events (ADEs), and sociodemographic factors. The cross-sectional study was conducted at a major teaching hospital from October 2022 to April 2023, recruiting 135 inpatients aged 18 and older. Data were collected through face-to-face interviews using validated questionnaires including the HLS-EU-Q16 for HL and EQ-5D-5 L for HRQoL assessment. Results showed sufficient HL among 64.4% of the participants, which was associated with gender, marital status, and occupation. Patients with sufficient HL demonstrated higher HRQoL measures and better antibiotic knowledge. Those with insufficient HL were more likely to engage in risky medication practices and hold misconceptions about antibiotic use. No significant link was found between HL and healthcare utilization or ADEs. The findings underscore HL's critical impact on inpatient healthcare outcomes. By integrating HL assessment into clinical practice and implementing targeted educational initiatives, particularly on antibiotic use, healthcare providers can empower patients to make informed decisions and enhance health outcomes.

Keywords Health literacy, Antibiotics, Quality of life, Health outcomes

Health literacy (HL) refers to an individual's capacity to obtain, understand, evaluate and apply health information and services in order to make informed decisions about their own healthcare[1]. HL is increasingly recognized as a predictor of health-related outcomes, making it a major public health concern. A systematic review by Berkman et al. found that low levels of HL were consistently associated with more frequent use of emergency care and hospitalizations; inappropriate medication use; lower capacity to interpret labels and health messages; and, among the elderly, poorer general health status and elevated mortality rates[2]. Moreover, patients with limited HL and poor understanding of medication instructions are deemed to be at a greater risk for adverse drug events (ADEs) and medication errors[3–5].

Antibiotics are one of the drug classes most implicated in medication misuse in our region[6]. This is a critical issue as it contributes to the antibiotic resistance crisis, affecting not only individual patients but entire populations. Our nation is in fact witnessing an alarming increase in multi-drug resistant pathogens, with rates reaching the higher end of levels reported globally [6–10]. The findings of surveillance data suggest an overall decrease of 5–10% in bacterial susceptibility to commonly used antibiotics, from 2011 to 2013 to 2015–2016. Such data reveal similar trends to findings from eastern and southeastern European countries[10].

Inadequate knowledge of antibiotic use and resistance resulting in misuse may be attributed to limited HL, as indicated in the literature[11–13]. Several studies have exposed public misconceptions regarding antibiotics and associated self-medication practices in Lebanon, including the use of antibiotics without a physician's prescription, as treatment for viral infections, and premature interruption of treatment once symptoms

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improve[14,15]. However, the association between HL levels and antibiotic use and knowledge is yet to be studied in the context of the Lebanese population.

Health-related quality of life (HRQoL) is defined by an individual's perception of their function and wellbeing with respect to physical, mental and social domains of health and it is measured by using the instrument EQ-5D-5 L [16,17]. HRQoL has been shown to be negatively impacted by poor HL in different patient populations including geriatric, cancer, type 2 diabetes and surgery patients[18–20].

Although there are some previously published studies that have tackled HL in Lebanon, none have explored HL's effect on health-related outcomes. As such, the aim of this study was to evaluate the association between HL and several patient outcomes including HRQoL, increased need for health services, ADEs, antibiotic misuse, antibiotic knowledge, and to assess the link between HL and sociodemographic and other health-related factors.

Methods

Design, setting and Patient Population

A single-center cross-sectional study was conducted at a 138-bed teaching hospital between October 2022 and April 2023. Inpatients across the various medical and surgical hospital wards were screened for eligibility, and data were collected through face-to-face interviews that were conducted by a single interviewer using a validated questionnaire. Patients aged 18 years or older were included in the study, while patients who were treated in a critical care unit, had an altered mental status at the time of the study, or did not speak Arabic or English were excluded. Written informed consent was obtained from all participants and all patients' identifiers were removed from all sections of the manuscript including the supplementary information. All methods were performed in accordance with the relevant guidelines and regulations This study was approved by the university Institutional Review Board under expedited review.

Endpoints

The primary endpoint was the level of HL as determined by the validated European Health Literacy Survey Questionnaire-modified short version "HLS-EU-Q16"[21]. This tool, developed by the European Health Literacy (HLS-EU) consortium as part of the European Health Literacy project, is available in English and Arabic, with the latter version validated in Arabic-speaking communities[22,23]. It comprises 16 items measuring the capacity to obtain, understand, assess and apply health information across three subdomains: healthcare (questions 1–7), disease prevention (questions 8–12) and health promotion (questions 13–16). The score is a sum (range: 0–16) that defines three levels of HL: inadequate (0–8), problematic (9–12) and sufficient (13–16). For the bivariate analysis, the categories were dichotomized into two HL levels: insufficient (0–12) and sufficient (13–16).

Secondary endpoints were the associations of HL with the following: HRQoL, antibiotic consumption practices, antibiotic knowledge, health services used in the previous year (number of doctor visits, hospital admissions, emergency department visits), ADEs in the previous year, sociodemographic data (e.g., economic status, education level, geographic location) and health-related factors (e.g., chronic illnesses). HRQoL was examined using the previously validated Arabic version of the EuroQoL-5Dimension-5Level "EQ-5D-5L" questionnaire[24–26]. It consists of five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression, each of which has five levels of response ranging from "no problems" to "extreme problems". For each dimension, a 1-digit number expresses the level selected. The combination of the 5 dimensions results in a 5-digit number that represents a health state profile. Each health state is assigned a summary index score based on societal preference weights for the health state. These preferences may differ between countries as they represent national or regional values. In the absence of a country-specific EQ-5D-5 L value set for the study country; the United States value set was used. Scores of a health state range from 0 (equivalent to death) to 1 (equivalent to full health), with higher scores indicating higher health utility. The second part is the EQ visual analogue scale (EQ-VAS) which is a patient's self-rated health on a vertical visual analogue scale where the endpoints are 100 labelled "The best health you can imagine" and 0 "The worst health you can imagine"[24].

Antibiotic knowledge was tested using questions adapted from the validated World Health Organization "Antibiotic Resistance: Multi-Country Public Awareness Survey" completed in 2015 by around 10,000 respondents in 12 countries from across all six WHO regions, including two Arabic-speaking countries[27]. The survey was subsequently adapted by other countries including Lebanon. It included 8 true or false questions for which the scoring system was as follows: +1 point for each correct response and 0 points for each incorrect or "do not know" response. The resultant total score reflects the participant's knowledge about antibiotics and may range from 0 to 8, with a score of 8 indicating a high understanding about antibiotics and antibiotic resistance.

The patients were asked about the number of times they had been hospitalized, visited the emergency room, or had seen a doctor at a clinic during the previous year. They were also asked whether they had experienced a side effect or reaction to a medication in the previous year; if yes, how many times, and to describe the incidence(s) mentioning the responsible medication(s) and the course(s) of action taken.

Statistical analysis

Data analysis was performed using SPSS version-28[28]. Descriptive statistics were expressed as means and standard deviations for numerical data and as frequencies and percentages for categorical data. As part of the bivariate analysis, Pearson's chi-square (or Fisher's exact test when appropriate) was used to assess the association of the different variables with HL (categorized as sufficient and insufficient). Additionally, Pearson's correlation was used to test for linear association between numerical variables (such as HRQoL and antibiotic knowledge scores) and the HL level. The correlation strength (r_s) was interpreted based on Cohen's guidelines, as follows: strong (>0.50), moderate (0.31–0.50), weak (0.11–0.30), and trivial/none (<0.10)[29]. A multivariable logistic regression analysis explored independent associations of variables with HL, testing all variables with a p-value ≤ 0.2 at the

bivariate level[30]. Sample size was determined using a medium effect size of 0.5 yielding a minimum sample size of 126 for a power of 80%.

Results

A total of 153 inpatients were screened on non-critical care inpatient units, of whom 135 were recruited for this study. The sample included 57% medical patients and 43% surgical patients, primarily undergoing orthopedic, cardiothoracic and urologic surgeries. Table 1 summarizes the participants' sociodemographic and health information including hospitalizations, clinic and emergency department visits, prescription and non-prescription medication use, and ADEs. The average HL score for the study participants was 13.4 (range of 6–16) with 64.4% of the sample exhibiting sufficient HL. The 16 questions assessing participants' HL revealed that the majority reported a difficulty level of fairly to very easy for most items, with the highest level of difficulty being observed for the three questions, 'judging if the information on health risks in the media is reliable', 'deciding how you can protect yourself from illness based on information in the media', and 'finding information on how to manage mental health problems like stress or depression'. Appendix A delineates the answers to the HL questionnaire.

59 patients (43.7%) reported having taken an antibiotic in the six months prior to the study, with nearly all of them (56 patients, or 95%) receiving a prescription for it. Most participants indicated that they typically obtained their antibiotics from a pharmacy, while 22.2% reported using leftover antibiotics from home, and 12.6% took antibiotics offered by friends or family. Notably, 59.3% of patients admitted to being unfamiliar with the term "antibiotic resistance". Among those who were familiar with the term, only 38.2% reported learning about it from a healthcare provider, while others stated family/friends (25.5%) and media (25.5%) as their information sources. (Table 2) The true/false questions, used to evaluate the antibiotic knowledge among participants, revealed an average passing score of 50% on the 8 questions. Appendix B delineates the answers to this questionnaire.

The average EQ-5D-5 L score using the United States tariff was 0.68, while the average EQ-VAS reflecting the patients' perceived health was 63.5. (Table 3)

Association between HL and the different variables

The association between the different variables and HL was examined using bivariate analyses. (Tables 4 and 5) Females were significantly more likely to have sufficient HL scores compared to males (75.7% vs. 50.8%; $p = 0.003$). Single individuals showed a greater likelihood of sufficient HL (78.1%) compared to married (64%) and to divorced or widowed participants (41.2%); $p = 0.036$. Moreover, participants currently or previously employed in the health sector showed a significantly higher likelihood of having sufficient HL compared to those without such experience (85% vs. 60.9%; $p = 0.037$). Both the categories of "most advanced degree in education" and "total household income" exhibited a borderline significant association with HL ($p = 0.051$ and $p = 0.052$, respectively). The remaining sociodemographic characteristics did not predict a significant change in HL scores. There was no significant association of HL with health outcomes, including number of comorbidities, medications, ADEs, and health services used in the previous year.

When comparing the sufficient and insufficient HL categories, no significant difference was observed in terms of HRQoL measures, EQ-5D-5 L ($p = 0.259$) and EQ-VAS ($p = 0.057$).

Regarding HL's link to antibiotic use and knowledge, patients with insufficient HL were less likely to obtain antibiotics from pharmacies with a prescription ($p = 0.006$), more likely to accept antibiotics from friends or family ($p = 0.007$), and less likely to be familiar with the term "antibiotic resistance" ($p < 0.001$). Conversely, those with sufficient HL were more likely to cite media and educational sources as their primary channels for information about antibiotic resistance ($p = 0.019$). Furthermore, patients with sufficient HL demonstrated significantly higher antibiotic knowledge scores compared to those with insufficient HL (average score of 4.5 vs. 3.1 out of 8; $p < 0.001$). However, there was no statistically significant difference between both groups in terms of antibiotic use in the past six months ($p = 0.341$), acquisition of antibiotics without a prescription from the pharmacy ($p = 0.703$) or the use of left-over antibiotics at home ($p = 0.471$). (Tables 4 and 5)

The correlation analysis revealed a linear positive but weak correlation between HL and EQ-5D-5 L ($r_s = 0.23$), EQ-VAS ($r_s = 0.24$) and the antibiotic knowledge score ($r_s = 0.32$); $p < 0.001$. (Table 6) The multivariable logistic regression analysis revealed the odds of having sufficient HL to be higher in females compared to males (OR = 3.7; 95% CI 1.57 to 8.82; $p = 0.003$), in single individuals compared to those who were divorced/widowed (OR = 7.1; 95% CI 1.61 to 31; $p = 0.009$;), and among those familiar with the term 'antibiotic resistance' (OR = 3.7; 95% CI 1.52 to 9.15; $p = 0.004$).

Discussion

Research on HL locally is at its outset where studies have focused on validating Arabic versions of HL assessment tools and exploring sociodemographic and health-related factors as potential predictors of HL[22,31]. This study investigated the association of HL with several patient outcomes, in addition to assessing HL and identifying its predictors, filling a gap in the regional literature. Around two-thirds of the study sample (64.4%) showed sufficient HL. This was a higher proportion than that found in the Lebanese study by Bouclaous et al., whereby 56.2% had sufficient HL, also assessed using the HLS-EU-Q16 tool. To note, the sample in that study was taken from five medical institutions in Lebanon: one public, one military and three private hospitals. As such, the difference may be potentially explained by the disparity in sociodemographic characteristics (e.g., income, education, etc.) across the country's private and public hospital patient populations.

	N	%
Age		
18–40 Years Old	35	25.9%
41–60 Years Old	39	28.9%
>60 Years Old	61	45.2%
Mean ± SD (years)	54.1 ± 17.6	
Gender		
Male	61	45.2%
Female	74	54.8%
Marital Status		
Single	32	23.7%
Married	86	63.7%
Divorced/Widowed	17	12.6%
Area of Residence		
Beirut	57	42.2%
Mount Lebanon	59	43.7%
Others	19	14.1%
Nationality		
Lebanese	126	93.3%
Other	9	6.7%
Degree in Education		
High School	31	23.0%
Bachelor's	47	34.8%
Masters/Doctorate/PhD	24	17.8%
None of the above	33	24.4%
Currently Employed	68	50.4%
Currently/ Previously Employed in the Health Sector	20	14.8%
Total Household Income compared to country average wage		
Very low	18	13.3%
Low to Middle	38	28.1%
Average to High	57	42.2%
Do Not Know/Prefer Not to Respond	22	16.3%
Health Care Coverage		
Private	64	47.4%
Public	21	15.6%
Mix	41	30.4%
None	9	6.7%
Smoking Status		
No	78	57.8%
Yes, regularly	33	24.4%
Yes, occasionally	24	17.8%
Alcohol Consumption		
No	65	48.1%
Yes, regularly	11	8.1%
Yes, occasionally	59	43.7%
Most common Chronic Health Conditions		
None	19	14.1%
Hypertension	46	34.1%
Heart diseases	38	26.7%
Dyslipidemia	31	23.0%
Bone/Joint Disease	30	22.2%
Gastrointestinal Disease	29	21.5%
Cancer	25	18.5%
Diabetes Mellitus	23	17.0%
Psychiatric Illness	17	12.6%
Allergies	15	11.1%
Continued		
Prostate Disease	14	10.4%

	N	%
	Mean ± SD	
Number of Comorbidities	2.8 ± 2.3	
Number of Prescription Medications	2.9 ± 3.5	
Number of Non-Prescription Medications/Supplements/Herbal Products	1.3 ± 1.6	
Number of Hospitalizations in Previous Year	1.1 ± 2.6	
Number of ER Visits in Previous Year	0.4 ± 0.7	
Number of Outpatient Clinic Visits in Previous Year	4.4 ± 10.5	

Table 1. *Sociodemographic and Health Information*.

Out of the 135 participants	***N***	**%**
Antibiotic Use During Last 6 Months	59	43.7%
Based on Prescription*	56	94.9%
Reason for Antibiotic Use*$^{\Delta}$		
Respiratory	23	39.0%
Genitourinary	9	15.3%
Gastrointestinal	8	13.6%
Surgical prophylaxis	8	13.6%
Dental	7	11.9%
Skin and soft tissue or others	7	11.9%
Usual Source of Antibiotics¶		
From pharmacy with a medical prescription	131	97.0%
From pharmacy without a medical prescription	45	33.3%
Left-over medications at home	30	22.2%
Medications offered by friends or family	17	12.6%
Have you heard of the term "antibiotic resistance"? If yes, where did you hear about it?		
No	80	59.3%
Yes	55	40.7%
Health Care Provider†	21	38.2%
Family/Friend†	14	25.5%
Media†	14	25.5%
Other Sources†	15	26.5%
Do you think the following statements are TRUE		
You may use antibiotics that were given to a friend or relative, as long as they were used to treat the same condition. *	17	12.6%
Antibiotics cannot kill viruses. $^{\Delta}$	49	36.3%
If you get a sore throat, you should take antibiotics to prevent the development of a more serious illness. *	38	28.1%
You can discontinue an antibiotic once your symptoms improve. *	30	22.2%
Treating a cold or a flu with antibiotics allows a faster recovery from symptoms. *	46	34.1%
Antibiotic resistance happens when your body becomes resistant to antibiotics, and they no longer work as well. *	60	44.4%
Antibiotic resistance is only a problem for those who take antibiotics regularly. *	35	25.9%
There isn't much, people like me can do to stop antibiotic resistance. *	34	25.2%

Table 2. Antibiotic consumption and familiarity with Antibiotic Resistance. *Percentage is out of those who reported taking an antibiotic within the last 6 months. $^{\Delta}$ Sum of percentages exceeds 100% since some patients reported using ≥ 1 antibiotic for ≥ 1 reason. ¶ Sum of percentages exceeds 100% since some patients reported ≥ 1 source of antibiotics. †Percentage is out of those who have heard of the term "antibiotic resistance". Sum of percentages exceeds 100% since some patients reported ≥ 1 source of information.

Sociodemographic predictors and HL

Females were more likely to exhibit sufficient HL. This finding was concurrent with other surveys and may be associated with the traditional role of women caring for ill family members and children, which advances their skills in navigating and interacting with the healthcare system[32,33]. Single individuals showed higher HL scores compared to their married, divorced, or widowed counterparts. A similar pattern has been observed in other studies, although conflicting data exist on the role of marital status in HL[34,35]. This difference might be related to married individuals devoting less time to health-related issues due to their preoccupation with more responsibilities. Additionally, divorce or loss of a spouse may affect an individual both psychologically and

	No Problem		Slight Problem		Moderate Problem		Severe Problem		Unable or Extreme Problem	
HRQoL Dimension	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**
Mobility	61	45.2%	36	26.7%	22	16.3%	9	6.7%	7	5.2%
Self-Care	*92*	*68.1%*	*21*	*15.6%*	*10*	*7.4%*	*6*	*4.4%*	*6*	*4.4%*
Usual Activities	*83*	*61.5%*	*19*	*14.1%*	*16*	*11.9%*	*4*	*3.0%*	*13*	*9.6%*
Pain/Discomfort	*45*	*33.3%*	*36*	*26.7%*	*32*	*23.7%*	*15*	*11.1%*	*7*	*5.2%*
Anxiety/Depression	*38*	*50.4%*	*40*	*29.6%*	*20*	*14.8%*	*5*	*3.7%*	*2*	*1.5%*
EQ-5D-5 L Score Mean ± SD	*0.68 ± 0.31*									
EQ-VAS (Mean ± SD)	*63.5 ± 19.9*									

Table 3. Health-Related Quality of Life Questionnaire.

			Health Literacy Score				
			Insufficient (0–12)		Sufficient (13–16)		
			N	%	N	%	p-value
Sociodemographic Characteristics	Age Groups	18–40 years old	9	25.7%	26	74.3%	
		41–60 years old	11	28.2%	28	71.8%	
		> 60 years old	28	45.9%	33	54.1%	0.072
	Gender	Male	30	49.2%	31	50.8%	
		Female	18	24.3%	56	75.7%	0.003
	Marital Status	Single	7	21.9%	25	78.1%	
		Married	31	36.0%	55	64.0%	
		Divorced/widowed	10	58.8%	7	41.2%	0.036
	Area of Residence	Beirut	20	35.1%	37	64.9%	
		Mount Lebanon	21	35.6%	38	64.4%	
		Others	7	36.8%	12	63.2%	0.990
	Most Advanced Degree in Education	None	17	51.5%	16	48.5%	
		High School	13	41.9%	18	58.1%	
		Bachelor's	13	27.7%	34	72.3%	
		Masters/PhD	5	20.8%	19	79.2%	0.051
	Current/ Previous Employment in the Health Sector	No	45	39.1%	70	60.9%	
		Yes	3	15.0%	17	85.0%	0.037
	Current Employment	No	29	43.3%	38	56.7%	
		Yes	19	27.9%	49	72.1%	0.063
	Total Household Income	Very low	11	61.1%	7	38.9%	
		Low to Middle	13	34.2%	25	65.8%	
		Average to High	17	29.8%	40	70.2%	0.052
	Health Care Coverage	None	5	55.6%	4	44.4%	
		Private	37	35.2%	68	64.8%	
		Public	6	28.6%	15	71.4%	0.364
	Smoking Status	No	28	35.9%	50	64.1%	
		Yes	20	35.1%	37	64.9%	0.923
	Alcohol Consumption	No	23	35.4%	42	64.6%	
		Yes	25	35.7%	45	64.3%	0.968

Table 4. Association of Health Literacy with Sociodemographic Characteristics.

financially, which may be linked to the lower HL observed in such individuals. As expected, work experience in the health sector predicted sufficient HL. The borderline statistical significance of HL's relationship with education and income could be due to the small number of participants with higher education or higher income, but this could also suggest a nuanced relationship related to the complex, multifaceted nature of HL determinants. For instance, someone with higher education might still struggle with HL if they lack healthcare access or experience language barriers. Similarly, higher income doesn't automatically translate to better HL. This complexity points

				Health Literacy Score				
				Insufficient (0–12)		Sufficient (13–16)		
				N	%	N	%	p-value
Antibiotic Use and Knowledge	Antibiotic Used in the Past 6 Months		No	23	31.1%	51	68.9%	
			Yes	23	39.0%	36	61.0%	0.341
	Usual Source of Antibiotics	From pharmacy with a prescription	No	4	100%	0	0.0%	
			Yes	44	33.6%	87	66.4%	0.006
		From pharmacy without a prescription	No	33	36.7%	57	63.3%	
			Yes	15	33.3%	30	66.7%	0.703
		Left-over medications at home	No	39	37.1%	66	62.9%	
			Yes	9	30.0%	21	70.0%	0.471
		Medications offered by friends or family	No	37	31.4%	81	68.6%	
			Yes	11	64.7%	6	35.3%	0.007
	Familiarity with the Term Antibiotic Resistance		No	39	48.8%	41	51.2%	
			Yes	9	16.4%	46	83.6%	< 0.001
	Source of Information about Antibiotic Resistance	HCP	No	44	38.6%	70	61.4%	
			Yes	4	19.0%	17	81.0%	0.085
		Media	No	47	38.8%	74	61.2%	
			Yes	1	7.1%	13	92.9%	0.019
		Health Campaign	No	48	35.8%	86	64.2%	
			Yes	0	0.0%	1	100%	0.456
		Family/Friend	No	45	37.2%	76	62.8%	
			Yes	3	21.4%	11	78.6%	0.243
		Others	No	47	38.8%	74	61.2%	
			Yes	1	7.1%	13	92.9%	0.019
				Mean	SD	Mean	SD	p-value
	Antibiotic Knowledge (True or False) Score			3.1250	1.78200	4.4943	1.86069	< 0.001
HRQoL	EQ-5D-5 L			0.6377	0.30172	0.7006	0.31250	0.259
	EQ-VAS			59.17	18.228	65.95	20.403	0.057

Table 5. Association of Health Literacy with Antibiotics Use and Knowledge, and HrQoL.

Variables	Health Literacy Score	EQ-5D-5 L	EQ-VAS	Antibiotic Knowledge Score
Health Literacy Score	1	0.225*	0.235*	0.321*
EQ-5D-5 L		1	0.367*	0.013
EQ-VAS			1	0.095
Antibiotic Knowledge Score				1

Table 6. Correlation of health literacy score, EQ-5D-5 L, EQ-VAS, antibiotic knowledge score. Note. *p-value < 0.001.

to HL being determined by factors such as healthcare access, and social support networks. Both income and education have previously been established as predictors of better HL[22,32,36]. Bouclaous et al. revealed age of ≥ 60 years as a predictor of insufficient HL, which was not in line with our study that did not detect a relation between age and HL[22]. In terms of geographical location, we had an underrepresentation in our sample from rural areas. Therefore, we could not infer any association between HL and area of residence.

Health outcomes and HL

With respect to the need for healthcare services, our study did not find a correlation between HL and outpatient clinic visits, emergency care use or hospitalizations. There is mixed evidence on HL as a predictor for healthcare utilization. For instance, Baker et al. found that patients with inadequate HL were more likely to be hospitalized and to visit their physicians in the clinic. However, the effect of HL on the use of health services disappeared after controlling for economic factors, age, and health status[37,38]. On the other hand, Lee et al. did not find an association between HL and increased healthcare use[39]. The controversial finding could be due to the use of self-reported measures of healthcare utilization over limited time frames in most studies, different study populations in terms of age and ethnicity, and the use of different HL scales. Baker et al. included Medicare patients who were at least 65 years of age from four big cities in the United States. On the other hand, Lee et al. included Taiwanese adults, who were 18 years and older[38]. In our opinion, linking HL to more objective measures of

healthcare use (i.e., patient records) over an extended time period is preferred. Furthermore, our findings do not suggest that the risk of ADEs increases in patients with insufficient HL. This contrasts with previous reports connecting limited HL to a higher risk of ADEs and medication errors, often attributed to poor understanding of prescription instructions and precautions[5]. This discrepancy may stem from our reliance on patients' self-reports, which limits the accuracy of assessing this outcome.

Concerning HRQoL, patients with a full sufficient HL score were found to have significantly higher HRQoL measures of EQ-5D-5 L that encompasses five HRQoL dimensions and EQ-VAS which reflects the participants' perceived overall health. This was in accordance with data across studies from different patient populations, including older adults in the United Kingdom, cancer patients in the United States, type 2 diabetes patients in Iran and surgical patients in Sweden[18–20]. Our correlation analysis revealed a weak correlation between HL and both HRQoL measures (r_s=0.23 for EQ-5D-5 L and r_s=0.24 for EQ-VAS; $p<0.001$). Likewise, a systematic review showed a moderate correlation between HL and HrQoL ($r=0.35$ $p<0.05$)[40]. The weak correlations observed between HL and HRQoL measures could be explained by several factors such as the nature of these two instruments and the extent of what they can capture, their possibly non-linear relationship likely influenced by other variables not accounted for in the analysis, and the need to consider individual contexts and support systems.

Antibiotic use, antibiotic knowledge and HL

Regarding the use of antibiotics, our study highlighted several important misconceptions among patients. 50.4% of participants believed that antibiotics can kill viruses which was analogous to the finding in another Lebanese survey by Jamhour et al. (51%)[14]. Moreover, 33.3% of our sample reported acquiring their antibiotics from pharmacies without a prescription compared to 51%, in the same aforementioned survey, who received their antibiotics without a prescription. However, in the latter study, there was no specific information related to whether patients received antibiotics from a friend or a relative. Our study showed that 12.6% of participants specified that they received antibiotics from a friend or a relative. Therefore, our study findings are consistent with Jamhour et al.'s findings.

Furthermore, the moderate correlation between antibiotic knowledge and HL scores highlights the need for awareness programs targeting individuals with both insufficient and sufficient HL.

This includes specifically the urgent need for targeted education on antibiotic use and the importance of prescriptions, particularly for individuals with limited HL. Additionally, it is important to recognize that the Lebanese healthcare system allows the over-the-counter purchase of prescription-only medications, which contributes to this issue. Similar results addressing the link between HL and antibiotic use and knowledge have been reported previously. A study conducted in Jordan showed that participants who demonstrated adequate HL (about two-thirds of the sample) were more likely to have a better understanding of antibiotics and antibiotic resistance[12]. In addition, participants of a cross-sectional study in Iran who had practiced self-medication with antibiotics had significantly lower average total HL scores[5,13]. Similarly, another cross-sectional study recently conducted in the UAE found an association, albeit not statistically significant, between adequate HL and self-medication with antibiotics[41]. Similar findings also extend beyond the Middle Eastern region. A scoping literature review involving primarily US-based studies showed that limited or insufficient HL was associated with reduced adoption of protective practices such as immunization and with reduced understanding of appropriate antibiotic use, although the relationship was not found to be consistent or linear[11]. Of interest, when asked about where they had heard of the term "antibiotic resistance", patients who were sufficiently health literate were more likely to mention the media as a source of information. This was consistent with prior research that found that people with lower HL were less likely to rely on the internet for health information[42,43].This may be linked to their difficulty in evaluating the validity and credibility of such health information and differentiating low quality from high quality sources. Therefore, there is a need for support from healthcare providers who can direct patients to high quality health information platforms such as the World Health Organization and the Center for Disease Control websites and guide them in identifying reliable sources[44].

This study has several limitations. Firstly, its cross-sectional design, which does not allow establishing causal relationships. Secondly, data collection relied fully on patient self-report, subjecting the results to recall bias which may have especially impacted the accuracy of the health information conveyed by the participants. Furthermore, it is difficult to rule out the effect of social desirability bias on patient responses to certain sociodemographic and behavioral questions such as income, smoking, alcohol use and antibiotic consumption practices. Efforts to minimize such bias included ensuring the anonymity and confidentiality of the shared information and wording interview questions in a neutral manner. Additionally, this is a single-center study which took place in one of the main university hospitals in the city of Beirut, Lebanon's capital. The majority of recruited patients were residing in the governorates of Beirut and Mount Lebanon, which constitute Lebanon's main urban area, while a minority were living in rural regions. The single-center nature and underrepresentation of rural participants limit the generalizability of the results to the entire Lebanese population. It is noteworthy, however, that the proportion of urban residents in Lebanon is estimated at 88.6%, making up the majority of the population[45]. Since study participants were recruited from the hospital setting, they may have had worse health compared to the general population. Moreover, data was not collected from patients who were too ill to participate in the study which may have affected the results. Finally, the use of a US value set for EQ-5D-5 L in the absence of a local set could introduce bias due to cultural differences in health state preferences.

To our knowledge, this is the first study conducted in the country to have measured HL while assessing its link to several patient outcomes. Our findings indicate that insufficient HL is associated with misconceptions regarding antibiotic use, decreased knowledge about antibiotic resistance, and potentially risky medication practices. Moreover, while sufficient HL is linked to better HRQoL measures and a greater understanding of health-related concepts, it also appears to be influenced by sociodemographic factors such as gender, marital

status, and occupation. Potential future directives, as recommended by the Institute of Safe Medication Practices, include utilizing HL screening tools at the bedside, which can be especially useful since low HL is often unnoticeable[46]. Such assessments would thus make clinicians aware of the HL status of their patients which can help them tailor their communication styles accordingly and offer additional support where needed. Furthermore, certain patient education practices performed in the inpatient setting can be enhanced in order to target inadequacies in HL, particularly regarding antibiotic knowledge, through proper patient counseling, simplified and clear educational materials provided at the hospital or shared online via social media platforms, as well as initiatives like health awareness days and campaigns[46]. Indeed, strategies aimed at improving HL have been recognized by reputable medical associations as contributors to enhanced clinical outcomes and self-care[46,47]. The US Department of Health and Human Services 'National Action Plan to Improve Health Literacy' provides a solid framework for organizations and healthcare providers towards a more health literate society. It includes useful suggestions for definite goals (e.g., provision of accurate and accessible health information, increase in basic HL research and promotion of policy changes) and specific evidence-based interventions (e.g., computer-based participatory programs, plain language and pictogram medication handouts, etc.)[48].

Future research should focus on implementing HL screening tools in clinical settings to tailor communication and support, enhancing patient education practices, particularly regarding antibiotic use, developing strategies to improve HL, as recommended by the Healthy People 2030 initiative, and conducting larger-scale studies, multicenter trials and meta-analyses to provide more robust conclusions on the association between HL and various patient outcomes.

In conclusion, this study highlights the significant association between HL and antibiotic use, knowledge, and HRQoL. It underscores the need for targeted interventions to improve HL, particularly in vulnerable populations, to enhance overall health outcomes and promote responsible antibiotic use.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Author contributions

H.M., E.R. and S.C.N conceptualized the study and its methodology. K.E. collected the data prospectively. H.D. and E.S. computed the statistical analysis. H.M., K.E., E.R. and S.C.N. performed data analysis and interpreted the results. K.E. and S.C.N. drafted original manuscript draft. H.M., E.R. and S.C.N. performed a critical review of the manuscript. K.E. and S.C.N. prepared all tables. All authors reviewed the manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

The study protocol was reviewed and approved by our institutional review board (IRB) at the Lebanese American University on September 14th, 2022. The IRB operates in compliance with the national regulations pertaining to research under the ministry of Public Health's Decision No.141 dated 27/1/2016 under our institution's IRB Authorization reference 2016/3708, the international guidelines for Good Clinical Practice, the US Office of Human Research Protection (45CFR46) and the Food and Drug Administration (21CFR56).

Additional information

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